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The Fuel Oils of California.

Three-Phase Transformer Manipulation.

The JOURNAL OF ELECTRICITY

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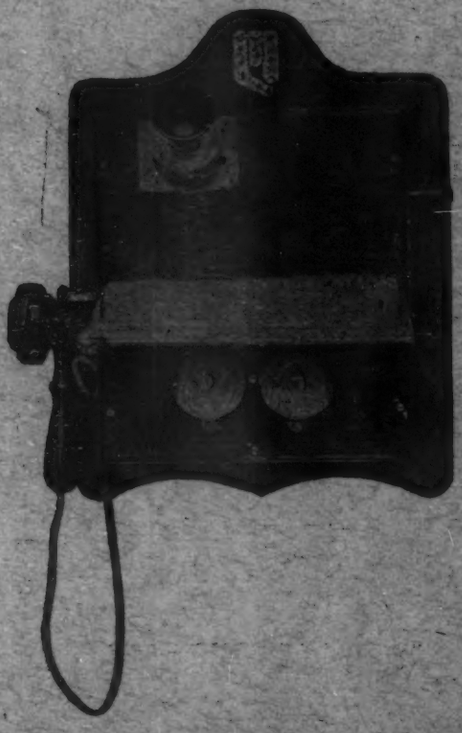

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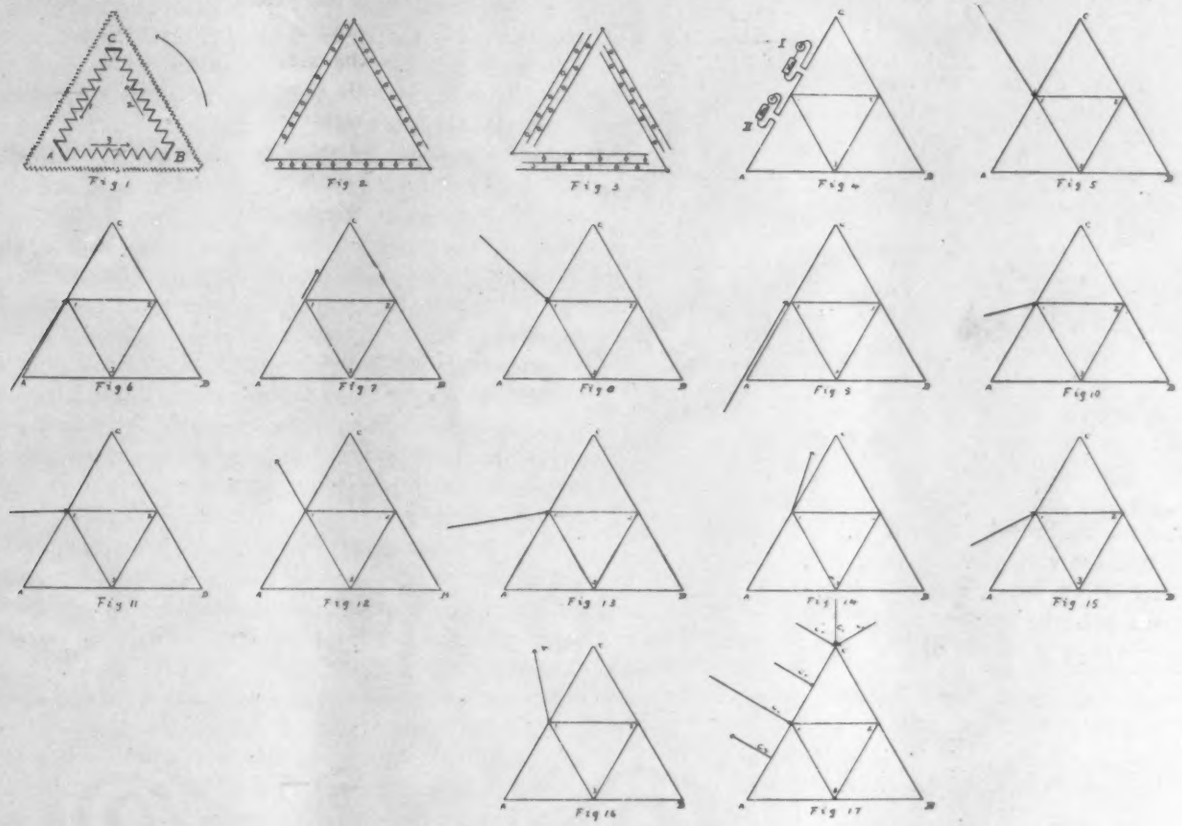
Three-Phase Transformer Manipulation.

BY A. J. BOWIE, JR.

NO other alternating current system at present in use offers as many different methods of obtaining and of using different voltages as the three-phase system. There are, of course, the "Y" and the delta connections commonly used, together with combinations of multipling the different coils of generators, motors, or transformers, as well as combinations of all these connections. It is also possible to obtain different three-phase voltages from the same set of transformers, and this article is the discussion of one method of so doing.



DIAGRAMS OF THREE-PHASE TRANSFORMER MANIPULATION.

Suppose the transformers are delta connected on the secondary, and that each secondary has a tap at its middle point. Then, obviously, there are four triangles which can be used, each of which will give half of the voltage of the main triangle, A, B, C. (See Figure 1.)

The triangle 1, 2, and 3, will, of course, give the most symmetrical arrangement and will divide the load more evenly than any of the others. If an evenly balanced load be connected to 1, 2, and 3, the result will be equivalent to the triangle 1, 2, C, supplying current for the load 1, 2. Likewise, A 1 and A 3 will supply 1 3 and B 2, and B 3 will supply 2 3 with current. Note that all cases considered apply to balanced loads alone.

Case 1 is with the load on 1, 2, 3 alone. If the load be non-inductive, then the current in C 1 will be nearly in phase with, and equal to, the current in 1 2; also the current in 1 A will be nearly equal to, and in phase with, current in 3 1. If the load be inductive, then the current in C 1 will lag behind the voltage 1 2 just as the current in 1 2 lags behind the voltage in 1 2; likewise with the currents in 1 A and 3 1.

Case 2 is with the load on 1, 2, 3 and also on A, B, C. In this case the currents in the transformers will be the

resultants of the two currents supplying the different loads. This will, in general, produce very different currents in the two halves of the same transformer when the power factors of the two loads are different—a result which at first sight would appear improbable as the arrangement seems to be perfectly symmetrical. However, by examining the graphical diagrams, this is easily explained.

A series of tests was made as follows: Three 1½-kilowatt, General Electric, type "C" transformers, 1040 volts primary, 115 or 230 volts secondary, were delta connected, giving about 240 volts on the delta. These were tapped in the middle at 1, 2, 3. The loads used were as follows: Three sets of ten 32 candle-power lights, delta-connected for 120 volts, making 30 lights in all for 1, 2, 3. (Figure 2.)

Three sets of ten 32 candle-power lights, delta-connected for 240 volts, (two in series) making 30 lights in all for A, B, C, as in Figure 3.

The motor load, which was the same in both cases, consisted of a 220-volt, 5 horse-power induction motor driving a fan. The motor was under-loaded, but when it ran on 1, 2, 3, it was not able to run up to speed, as the voltage was too low.

In each case the actual resultant current came out somewhat less than that obtained by combining graphically the two components. But this was caused by the drop in voltage when under combined loads, as the transformers were much over-loaded in some cases. The direction of the current was found by using a wattmeter and taking the voltage off 1, 2, 2, 3, and 1, 3, respectively. Of course, this could have been found by the ordinary voltmeter, ammeter, and wattmeter method. An ammeter was placed in series with a wattmeter, and they were both placed in between C and 1, (which is designated by I), and after that between 1 and A, (designated by II in Figure 4).

The arrow indicates the phase and the amount of current flowing from C to 1, or from 1 to A in the transformer. The wattmeter and ammeter were standard instruments, but were not calibrated, as great precision was not aimed at; besides, the voltage varied somewhat while the readings were being taken, which would account for small discrepancies in the results.

The following is the list of diagrams:

CASE	LOAD	CURRENT	FIGURE
I	Motor on 1, 2, 3	19	5
II	Motor on 1, 2, 3	19	6
I and II	Lights on A, B, C	5.7	7
I	Motor on 1, 2, 3, and Lights on A, B, C	16.7	8
II	Motor on 1, 2, 3, and Lights on A, B, C	23	9
I and II	Motor on A, B, C	9.5	10
I	Lights on 1, 2, 3	10.2	11
II	Lights on 1, 2, 3	10.2	12
I	Motor on A, B, C, and Lights on 1, 2, 3	18	13
II	Motor on A, B, C, and Lights on 1, 2, 3	11.5	14
I	Lights on A, B, C, and Lights on 1, 2, 3	12.7	15
II	Lights on A, B, C, and Lights on 1, 2, 3	13.2	16

With a non-inductive load on the center triangle alone, only half the current capacity of the secondary is available. The full capacity of the primary, however, is available, as was shown by readings of the primary current not given here.

Tests were made with the lamp load alone on the different small triangles giving 120 volts. When the lights were on 1, 2, 3, the currents in all secondary coils were alike. However, when any of the other triangles were used, then in two coils of different transformers the currents were greater, and in the remaining four coils were less than in the first case.

For triangle 1, 2, 3, the current equals 10 amperes.

For triangles A 1 3, B 2 3, or C 1 2, the current (in two coils) equals 13 amperes, and the current in the remaining four coils equals 5½ amperes.

When the light load was put on A, B, C, in addition to the other load, the maximum current in any secondary when 1, 2, 3 was used was 13 amperes, whereas the maximum current when any one of the other small secondary triangles was used was 17 amperes.

Provided the load be balanced, the best small triangle to put it on is 1, 2, 3. Even at best, poor efficiency as regards the use of secondary copper is obtained, and the voltage drop for any load is very large. However, there might be many places where a connection of this sort might be useful; for instance, in a station where there was a 440-volt service and it was desired to run a small 220-volt motor on the same transformers. It would be inadvisable to run a system of any extent in this manner.

A system which might be used would be to run out six wires from the station, A, B, C, and 1, 2, 3, and to use the small triangles A, 1, 3, C, 1, 2, and B, 2, 3, for the lower pressure motor service (for small motors), balancing the motors on the three different triangles, and to use A, B, C for the larger motors. If a good balance were obtained this would give full transformer capacity, and would be practically equivalent to an Edison three-wire system, obtaining the advantages of transmitting at a high voltage. However, in general this system would probably be considered too complicated to use, due principally to the difficulty of obtaining anything like the proper balance.

Another case of interest is where three economy coils are connected delta and are equally loaded at the middle points, thus reducing the voltage 50 per cent. Tests were made with an arrangement of this sort, using as a load the lamps shown in Figure 2. The current C, 1, which enters the vertex of the triangle, splits up into two components, C, 2 and C, 5, which are very nearly at right angles to the voltage in the coils in which they flow, and are also nearly equal to the entering current C, 1. They flow along the two halves of each coil of the economy coil in the same phase, but in opposite directions and unite at the central point, giving the current C, 4 flowing into the load equal to the difference of the currents in each half of the economy coil ($C_4 = C_2 - C_3$, Figure 17). Note that in C, 3, the current is flowing from 1 to A, and not from A to 1.

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"I cannot afford to be without THE JOURNAL OF ELECTRICITY; please renew my subscription," writes Mr. Frank Bourne, the well known mechanical and electrical engineer of New York City.

The Heretofore Unpublished Facts of the Pomona Case.

BY C. G. BALDWIN.

THE casual reference to the fact that William Stanley deserved the credit for the first commercial use of a 10,000-volt current in a long distance transmission plant, which appeared in my article in the January issue of the JOURNAL OF ELECTRICITY, seems to have excited some interest. As special attention has been called to this in an editorial note, I feel that it may be of further interest to know a bit of unwritten history.

The San Antonio Light and Power Company, of Pomona, based its plans upon the Frankfort experiment wholly, as at the time of its organization there was no commercial use of so high a potential in existence. It was necessary to convey the power thirty miles. The money to put in the plant was raised, and I went east to arrange the contract with the Westinghouse company, with which I had had correspondence.

I was greatly surprised to find that the then electrical engineer of the Westinghouse company was utterly unwilling to consider our plans. He maintained that the Frankfort Exposition transmission was a "laboratory experiment." The longest time it operated was five hours, while I must operate five hours or more for 365 days in each and every year.

"Our company," he said, "will not venture upon any such experiment."

I replied that the engineer who conducted the Frankfort work was a man of the highest reputation; that he said the insulation of the line gave him no trouble; that there did not appear a sufficient motive to make such a statement, if false; and that I believed commercial transmission at 10,000 volts was feasible and wanted to do it.

He still smiled at my credulity and firmly denied my request to consider it. When asked what he would recommend, he said "a 4000-volt generator and step-down transformers." I objected to the special make of a generator at our great distance, and especially to the cost of copper, which would be more than six times as great as I had figured upon. But I accomplished nothing. He said the Westinghouse company would not take the risk and pleasantly smiled me out of the office. I did not feel like smiling; I had apparently made a fool of myself, and a very public fool at that, having been at work for six months openly to organize the company. But I gave it up and dismissed the subject.

I then went immediately to Pittsfield, Mass., to attend a meeting of the American Board of Commissioners of Foreign Missions. Dr. R. S. Storrs, of Brooklyn, gave the address that evening. Its eloquence drove electricity from my mind, but as we left the hall the brilliantly lighted town suggested me to drop into a drug store to inquire whether there was an electrician of any prominence in town. The answer was "Yes; Stanley, of the Stanley Laboratory."

The next morning I went to Mr. Stanley's office, and threw down the plans and blue prints before him and asked him to look them over. He did so very hastily, and, closing them up, brought down his hand upon them, exclaiming, "Good! Good!"

"You don't mean to say that can be done, Mr. Stanley?"

"Done! Of course it can. Who says it can't be?"

"The Westinghouse company."

"Westinghouse company? Old fogies! Of course it can be done!"

He pushed a button and there came in from his laboratory some eight young men, among them Mr. Kelly, who has since won so prominent a place in the electrical engineering world. They sat down around the table and he read and commented upon the plans. He sent out for lunch and we were together until four o'clock that afternoon. Mr. Stanley went to the depot with me and on the way said: "I am not in the business of installing such plants. You go to the Thomson-Houston company and if they will not do it, why, I will. I can purchase their standard generators and we will make the transformers here. We will put up experimental lines, and we will guarantee results." I went to the Thomson-Houston company and they talked exactly as the Westinghouse company did. I had my talk with the secretary of the company, I think, but near the close of the conversation Mr. Coffin was present. When we finished, I arose to go, and laying my hand on the doorknob, said: "Well, gentlemen, I bid you good morning. I am glad there is one man in America who has the courage to undertake a new thing."

"What do you mean?"

"There is one man in America who will do this thing," I repeated.

"Who is it?" was asked, and both looked at me sharply.

"Stanley."

"Will Stanley do that?"

"Yes."

"Then we will. Come around in a week and we will give you figures." And they did.

Two weeks later I returned by Pittsburg and the Westinghouse company was ready to undertake the work. How the company had heard, I do not know, but it is certain that the company was ready, and it sent its agent, a Mr. Cook, to Pomona, and he got the contract, guaranteeing all results. This guarantee never cost the Westinghouse company a nickel, for, as I said in my paper referred to, the success was far beyond its highest hope.

The Westinghouse company is worthy of great praise and shares the glory; but it is clear that without Stanley the enterprise which led the world for high potential for two full years of commercial lighting by long distance electric transmission, would never have been undertaken. I undertook it from the standpoint of a layman, overestimating the value of the Frankfort experiment. Stanley was ready for it as an expert on transformers. He was splendid in his enthusiasm and he well deserves the credit given him.

The Fuel Oils of California.

STEAMING VALUE OF CALIFORNIA FUEL OILS.

BY GEO. H. LARKIN.

FUEL oil is found in various portions of the Pacific Coast, but its production has assumed proportions of commercial importance only in that portion of California from Fresno county southward. There are but four oil fields in California worthy of general consideration in a brief article of this character, and these four fields, named in the order of the fuel value of the oils they produce, are known as the Coalinga, Santa Paula, Los Angeles and Summerland grades of oil.

The chief characteristics of these oils are given in the following table, the calorific power being expressed in British thermal units per pound of oil, and the theoretical evaporation being shown in pounds of water evaporated from and at 212° F., per pound of oil consumed.

Variety	Gravity (Baumé)	Weight per bbl	Estimated Heat Units	Theoretical Ev'por'tion	Water in Suspension
Coalinga	36°	300	23,000	23.8 lbs.	0
Los Angeles.....	14°	340	19-20,000*	20 lbs.†	2% to 12%
Santa Paula.....	24°	320	21,000	21.7 lbs.	0
Summerland.....	13°	342	19-20,000*	20 lbs.†	5% up‡

As is evident from the above table, Coalinga oil stands at the head of the list both as regards heat units and gravity. It is also perfectly clean, no foreign matter whatever being contained in the oil. The Santa Paula oil comes next as a clean product, although it contains more asphaltum, and is, consequently, not so rich in heat units as is the Coalinga oil, which is, so far as the writer is aware, higher in heat units than any other known fuel oil.

Both the Los Angeles and the Summerland oils vary a great deal as to gravity, according to the location of the wells. Some wells in the Los Angeles district have produced oil having a specific gravity as high as 19 degrees B., while the specific gravity of oil from other wells in the same district is not over 12 degrees B. The output of different wells varies between these two points, but when put together in a storage tank, the mixture has a specific gravity of from 14 to 15 degrees B. The same conditions hold good in the Summerland district, except that there the oil is of a more stringy, viscous nature, and appears to hold more water and sand in suspension than is the case with the Los Angeles oil. All the different oils mentioned seem to have about the same fuel value per barrel, providing that clean oil can be obtained, but in the case of the heavier oils it is impossible to separate the impurities without driving off the volatile portions of the oil.

The application of crude petroleum as fuel under steam boilers in competition with coal is entirely a question of comparative prices. There is such a great range in the quality of coal used on the Pacific Coast, that it is impossible to give any standard of comparison. Only a general statement may, therefore, be made, viz.: from two to four barrels of oil are equal to one ton of coal, according to the quality and grade of coal and the efficiency of the fireman. By using the proper kind of retort oil burner, it is possible at all times to get nearly theoretical conditions when using petroleum as fuel, which, together with its ease of handling and the perfection of its regulation, make crude petroleum the ideal fuel for steam users.

It is possible, however, to obtain a satisfactory estimate of the comparative costs of coal and oil fuels in all instances where the specific costs of fuel and evaporative efficiencies are known. Let us assume, for instance, that a certain steam plant is burning Welsh anthracite coal costing $8.00 per long ton, giving an evaporative duty of 11 pounds of water per pound of coal. Under these conditions, at what price per barrel can oil be burned to equal or greater advantage than the coal?

Obviously, the ton of coal evaporates 24,640 pounds of water, and as Coalinga oil producers stand ready to guarantee the evaporation of 16 pounds of water per pound of oil, it will require 1540 pounds of oil to perform the work done by 2240 pounds of Welsh anthracite coal in the plant. If oil weighs 300 pounds per barrel, the 1540 pounds of oil used amount to 5.1 barrels. Now, as 5.1 barrels of oil are required to do the work performed by $8.00 worth of coal, the equivalent price per barrel for the oil is $8.00÷5.1, or $1.56, which shows the price which can be paid for oil to compete on terms of equality with Welsh anthracite under the conditions assumed. If the oil can be bought at a less price, the difference represents the gain (or loss) that will be effected by the change.

*According to gravity and purity.
†With clean oil.
‡Water and sand in suspension.

A TEST OF CALIFORNIA FUEL OIL.

BY A. M. HUNT, M. E.

AN estimate of the value of California fuel oil for steaming purposes is available in a series of tests made during the recent Midwinter Exposition in San Francisco, where Puente oil was used exclusively. The oil was delivered on the grounds in tank cars. Two storage tanks, each holding about 6000 gallons, were placed in a cribbed box sunk below the surface of the ground at the rear of the boiler annex. This box was planked over and covered with a layer of sand six to eight inches thick, with a trap door to allow access to the locked door in the top of each tank. The oil was run from the cars directly into the tanks by gravity flow. Each tank was fitted with a vent pipe, through which passed the float rod indicating the level of the oil.

A steam pipe was carried into the top of each tank, to be used as a smother pipe in case of fire. The oil was drawn from the tanks by either of two pumps situated between the two sets of boilers, a separate suction pipe being run to each tank. These pumps discharged into the bottom of a small receiving tank made by a 5-foot length of 12-inch wrought iron pipe, capped at both ends. The oil was delivered from the bottom of this tank, either directly to the burner line, or through a Worthington meter into the burner line. The pumps were provided with pressure control valves actuated by pressure through a small pipe led from the top of the small tank, and were set to maintain a constant pressure on the burner line of between 11 and 12 pounds, no matter how many burners were on. An overflow pipe back to the big tanks was provided with a pipe safety valve, set a few pounds heavier than the governors. The small tank was also provided with a glass gage, and a safety valve placed on the top.

The operation of this combination was eminently satisfactory, and was entirely automatic, except that it was occasionally necessary to admit a little air to the small tank, or to bleed a little off, to maintain a constant level. The oil header ran the full length in front of the boilers in a cement-lined trough, with a drainage well at either end, and was covered with plates of iron. From the header, branches were carried up to supply the burners. Steam for the burners was supplied through a small header running along in front of the boilers, branches being taken out of the top to furnish dry steam. The operations of the oil-burning plant, and the use of the oil, was in every way satisfactory. At no time was there any difficulty with it, and the freedom from smoke, coal dust, and ashes makes oil pre-eminently a satisfactory fuel. The total quantity of oil consumed from the time of commencing its use until the close of the Exposition was 691,041 gallons.

The boilers in which tests were made were the ones used in daily operation of the machinery of the Exposition. They were of a well known fire tube type, rated at 375 h.p. each, and were 8 in in number, arranged in two groups of 4 each. The fuel was crude petroleum, furnished by the Union Oil Co., of California, and is produced in Ventura county. The Graves burner, manufactured in St. Louis, Mo., was used. No calorimeter tests of the oil were made, hence a report of its thermal units is not given. The oil came in through a center tube from a pipe fed by a receiver in which a constant pressure of 12 pounds was maintained. The steam passed in through an opening, caught the oil and sprayed it into the furnace. The amount of steam thus used approximated 7 per cent. of the boiler evaporation. There were grooves in the steam passage which gave the issuing steam a twisting motion, which was supposed to aid in breaking up the oil. There were 8 such burners to each boiler. The air for combustion was supplied through a double bottom architectural hollow tile bottom to the furnace. No grate bars, bridge wall, or combustion chambers were used, but a pile of loose, rubble-like fire brick was thrown in the back end of the furnace. The feed water supplied was taken from a Webster vacuum heater and passed through a Worthington hot water meter. The oil consumed was also measured by a Worthington hot water meter. Although meter tests are generally regarded with suspicion, the writer is confident that the results in this case are reliable. Before any tests were made, the oil and feed-water meter was thoroughly calibrated by weighing. A series of three calibration tests of the Worthington oil meter made on May 2, May 17 and June 5, 1894, showed the weight of oil per metered gallon to be 7.304 pounds, 7.466 pounds, and 7.364 pounds respectively. A similar series of four tests of the Worthington water meter, made on May 5, 7, 14 and 31, 1894, showed the weight of water per metered cubic foot to be 61.40 pounds, 62.78 pounds, 62.52 pounds, and 62.85 pounds respectively, all tests being with hot water and pumping against a boiler pressure of 125 pounds. The average of these tests gave 7.378 pounds of oil per metered gallon, and 62.39 pounds of hot water per metered cubic foot.

At first it was impossible to get concordant results, and sets of observations taken with the water at a high temperature, were particularly poor. A pressure gage was finally placed in the feed pipe on the boiler side of the meter, and the discharge valves passing the water into the barrels for weighing were set so as to maintain on the meter an average pressure equal to that in the boiler. The pump was run at the same speed as was found necessary to supply the water to the boilers tested on May 26. It was found after so doing that the results of the different sets of tests, as shown above, agreed very closely, *i. e.*: within two-tenths of a pound per cubic foot registered. This was as close as the limit of accuracy of the scales. The oil meter was provided with vents to enable any gas which might collect at the top of the meter chambers to be removed.

On May 26, 1894, a careful and systematic test was made of boilers Nos. 1, 2, and 3. In preparing for the test, the feed pump connections, except the ones leading to these boilers, were blanked, and No. 4 was filled to a mark on the gage and found to have gained nothing at the conclusion of the test. The blow-off connections were blanked and precautions taken that there should be absolutely no loss of water from the boilers. The furnaces were all set, and the full load had been on the boilers for about one-half hour before the tests began, and during the continuance of the same none of the burners were altered. The test commenced at 6:15 p. m., the height of water in the boilers having been noted, and terminated at 11:15 p. m., at which time the water was at the same level as at starting. The steam pressure was maintained as nearly constant as possible, and the water kept at a constant level. The thermometer used in taking the temperature of the feed was tested and found to be accurate. Readings were taken at fifteen-minute intervals. A great difference in the evaporation on two consecutive nights, on the same boilers, and under the same conditions, was due to a slight change in the adjustment of the burners and showed how important this matter is.

Other tests were subsequently made to get the average evaporation for a period of twenty-four hours on the entire boiler load, and were commenced at 7:00 a. m. The load from 7:00 a. m. to 10:00 p. m. consisted only of the condensation of the pipes and the slow running of one of the fire pumps. One burner was kept low in each of the two boilers, with only one boiler cut into the header. It was the usual practice to keep one boiler, in addition to those in use, warmed up in case of an emergency. At 10:00 a. m. practically the full load was thrown on one boiler. At 12:30 p. m. the second boiler was cut into the header with about one-quarter load. At 1:30 it had about one-half its load, and the third boiler commenced warming up. At 3:35 commenced to warm up the other two boilers. At 6:20 cut in two more boilers, making four in operation. At 6:40 cut in the fifth boiler. The load until 10:00 p. m. continued until fairly constant, four boilers fully loaded, and one with partial load, at which time the boiler with partial load was cut out and burners reduced in others. At 10:30 cut out two more boilers. At 11:00, load was reduced to about one-sixth load of one boiler, and another kept warm. From 4:45 a. m. to 7:00 a. m. the only load was the condensation of the pipes and the movement of one fire pump.

The evaporation obtained was 12,986 pounds of steam per 1,109 pounds of oil, from and at 212°, or practically 13 to 1. This result was excellent when the amount of oil consumed in warming up and in keeping one boiler in constant readiness to be cut in, is considered.

DEVELOPMENT OF CALIFORNIA OILS.*

AS far back as 1857 an oil well was put down on North Spring street, near Franklin, in the city of Los Angeles, but after going down 800 feet, work on it was suspended. About the same time a well was sunk at Main and Requena streets and drilled to a depth of 900 feet, when it was abandoned. The Union Oil Company also expended at different times and in different places a considerable sum of money in its efforts to find oil in paying quantities.

It was not, however, until August, 1893, that oil was found in paying quantities. It was in a well put down near the junction of West State street and Lakeshore avenue. At a depth of 150 feet the well showed a yield of two barrels a day, and as it was selling for $2.00 a barrel, further work was vigorously prosecuted. Since that date the increase in production has been so great that the total production of the Los Angeles field alone up to the end of the year just closed, exceeds 5,100,000 barrels. That is the fact which has made the discovery of petroleum in Los Angeles one of the most important incidents in the history of the city.

Starting from August, 1893, the date when the oil industry of Los Angeles began its history, the production of each year has been as follows: In 1893, 100,000 barrels; 1894, 400,000 barrels; 1895, 900,000; 1896, 1,200,000; 1897, 1,400,000; 1898, 1,100,000; total, 5,100,000 barrels. During that period prices have ranged from 30 cents a barrel to $1.65 a barrel in the field. The minimum price was reached in May, 1895, and the maximum price in March, 1897. At the present time the average price per barrel is $1.00.

During the entire period of production, that is to say from August, 1893, to December 31, 1898, the average price of oil at the wells has been about 65 cents a barrel. Figuring on that basis, the total selling value of the oil produced in the Los Angeles field to the present time amounts to $3,315,000. This does not include the cost of drilling, erection of derricks, wages, and the other expenses incurred in the maintenance and pumping of the wells.

There have been, as nearly as can be determined, 1020 wells drilled in the Los Angeles field, of which 625 are now being pumped. The average cost of a well is $2300, making the total amount expended for the 1020 wells put down, $2,346,000. The average monthly cost for the maintenance of a well is $50, so that the wells now being pumped necesitates the disbursement of about $30,000 a month for wages and incidentals. The average

*Abstract from the Midwinter Number of the *Los Angeles Times*.

Los Angeles oil is about fourteen and a half gravity. The total amount collected by the city for licenses to oil men from April 1, 1897, date when the tax was imposed, to December 31, 1898, was $8585.

It is estimated that the petroleum production of southern California during the year just ended was in the neighborhood of 2,050,000 barrels, divided between Santa Barbara and Ventura counties, the Fullerton field in Orange county, and the Whittier, Puente, and Los Angeles fields in Los Angeles county. The production in the Fullerton fields shows a large increase over that of 1897. Whittier also shows an increase. For Ventura and Santa Barbara counties the combined production is estimated at 740,000 barrels for 1898, as against 660,000 barrels for 1897. The Los Angeles local field is the only one that will show a decrease, the figures for 1898 being placed at 1,100,000 barrels as against 1,400,000 barrels of production in 1897.

During the first half of the year 1898 the average production of the Los Angeles field was 4000 barrels a day. During the last half of that year the average production has been about 2800 barrels a day. At the present time the production is about 2300 barrels a day. Taking 2800 barrels as the daily average for the field for the last six months, the decrease, as compared with the first six months of 1898, would be 1200 barrels a day, or 216,000 barrels for the half year. It is not believed that the production during the present year (1899) will fall below the present production of 2300 barrels a day. Rather may it be expected that the year will show a slight increase on that average, a search for new oil deposits being prompted by the better prices now obtained. It is also quite possible that the cost of production will show a slight reduction, if, as is hoped, some of the wells now being deepened show an increased flow at greater depth.

Stocks which have just been taken show that at the close of 1898 there was above ground in the Los Angeles field 240,000 barrels of oil, of which 70,000 barrels were in tanks in the field, and 170,000 barrels in the various storage tanks in the city. At the present rate of consumption, this is equivalent to about four months' supply.

A peculiarity worthy of note in respect to the Los Angeles oil field is the comparatively small proportion of dry wells, and of wells that did not give a paying yield. During 1895, when prices broke to 30 cents a barrel, a number of the smaller wells were shut down, simply because it did not pay to pump them with oil at 30 cents a barrel. But under normal conditions such wells would not have been classed as non-payers, and would not have been shut down. Some of these wells are now being reopened and are being sunk to a greater depth with good results.

The Puente oil fields are in Los Angeles county, and about five miles distant from Puente Station, on the Southern Pacific Railway. Prof. W. L. Watts in his report on them to the California State Mining Bureau, says "the hills in which the Puente oil wells are situated, appear to be an east extension of a line of elevation which can be traced in a southeasterly direction from the city of Los Angeles. These hills, as seen at the Puente oil wells, are formed by a series of closely compressed folds in the rocky formation, which have an east and west trend. At the base of these hills soft sandstones and conglomerates are found, and in some places a white, chalk-like, diatomaceous rock, similar to that seen at Los Angeles, alternates with reddish-brown sandy strata, forming parti-colored banks, in which the strata vary from a few inches to less than an inch in thickness." About thirty wells in all have been drilled, only a few of which were non-productive. Generally speaking, the Puente wells have very remunerative, and there are reasons to believe that they can be made more largely productive than they have, when the necessity for an increased production arises. The production of these wells during last year was over 100,000 barrels.

The wells at Fullerton, in Orange county, are showing a considerable increase in yield. The Santa Fé Railway Company has sunk eleven wells in that district and is now sinking its twelfth. Besides the properties of the Santa Fé, some others have been lately located and companies formed to develop the oil deposits believed to exist in the Fullerton region. Among these is the Columbia company, which has sent in a quantity of machinery and will get to drilling without delay.

From January 1 to May 1, 1898, the average production of the Fullerton wells was 150 barrels a day. Since May 1 the production has increased, and the reports of the Santa Fé company show that from that date to the end of the year, the average production was 225 barrels a day. The total Fullerton production for the year 1898 was about 70,000 barrels.

Next to Los Angeles county, Ventura is the largest oil producing county in California. In 1897 its production was about 500,000 barrels. For 1898 its production is estimated at 560,000 barrels, with a continuing increase. The Union Oil Company of Santa Paula handles the bulk of the oil produced in Ventura county, the greater portion of which is shipped to Olean, near San Francisco, where it is refined. The company has an elaborate pipe line system, connecting Ventura with its different oil fields in the county, and the oil is either carried by gravity or pumped to the wharf at Ventura, where it is loaded on a tank steamer. The pipe line system is over 100 miles in length. The deepest wells in the state are those sunk by the Union Oil Company in Ventura county.

In Santa Barbara county the principal oil wells are at or near Summerland. The Summerland oil is a heavy oil more closely resembling the Los Angeles oil than that found in any other part of southern California. Within the last three months the production of the Summerland field has been greatly increased through the discovery of what are known as the "beach" wells. These wells are situated on the ocean beach below high tide mark, and they are the only beach wells known. They have proven themselves good producers and new wells are steadily going down. A peculiarity of these Summerland wells is the comparatively shallow depth at which natural gas is encountered, and in such abundant quantities as to furnish enough for partial lighting purposes. Only a few weeks ago in a well that was being drilled the pressure of gas was so great as to throw out all the boring tools. An effort will probably be made to discover to what extent this natural gas can be utilized.

It can be said that the petroleum industry of Los Angeles, and, in fact, of all southern California, is in a much better condition at the beginning of 1899 than it was a year ago, or at any previous time in its history.

Following is a report made by Prof. W. L. Watts, of the California State Mining Bureau, who has been making a systematic investigation of the petroleum deposits of southern California:

"A review of the petroleum industry in southern California shows continued activity in the Los Angeles oil field and the oil territories of the Puente, Santa Fé Railway Company, the Central Oil Company, in the Puente hills, the oil field of the Pacific Coast Oil Company near Newhall, and the oil fields of Ventura and Santa Barbara counties. The price of oil has also been more satisfactory than it was during 1896-97, and it is probable that the total output for 1898 will greatly exceed any previous annual output of petroleum in California. During 1898 there has been a marked tendency to exploit new territory. In Los Angeles county three new companies have commenced operations in the Puente hills, and new territory is being developed at three or four places near Newhall. At Los Angeles drilling was actively prosecuted during the first half of 1898 in the eastern extension of our local oil field, but recently little has been done toward extending its limits. There has been some exploitation in the outlying portions of Los Angeles, but the only marked success has been on the Maltman tract, where several comparatively shallow wells have been drilled which are remunerative. The only really new group of productive wells reported as being drilled in Los Angeles county during 1898 are those of the Home Oil Company near Whittier.

"In Ventura county drilling has been active on both sides of the Santa Clara river. This has resulted in many new and pro-

Reproduced from poor material

ductive wells being added to those already in operation. There have been reported from Ventura county several new wells drilled during 1898. On the south side of the valley of the Santa Clara river numerous new and productive wells have been drilled by the Union Oil Company; also several by the Eureka Oil Company. On the north side of the Santa Clara river the Modello Oil Company has sunk six productive wells near Piru, and there have been sundry developments by the Eureka and other companies in Hopper canyon. In the Sespe district several new and productive wells are reported to have been sunk. Garbutt & Co. have developed a new and productive territory; also on the Temescal ranch, near Piru, one productive well has been sunk by D. C. Cook, who is about to commence active operations on that ranch.

"In Santa Barbara county the principal development has been at or near Summerland, where a line of derricks extends not only along the seashore, but out into the ocean. The Arctic Oil Company is also drilling in the edge of the Santa Ynez mountains, near the Casitas creek, and some development has been made by the Occidental Oil Company, about five miles northeast of Summerland.

"In central California the most important event in the petroleum industry during 1898 has been the development of the Coalinga oil fields, in Fresno county, which is proving a valuable addition to our petroleum supply. Concerning the Moody Gulch oil field, in Santa Clara county, we have no data for 1898.

"The geological investigations concerning the occurrence of petroleum in California which have been made by me for the California State Mining Bureau during 1898, have been made along a line extending from the Santa Ana mountains, through the Puente hills, to Los Angeles along a line extending about ten miles inland from the seashore between San Diego county and Newport, in Orange county; also throughout certain territory in Ventura county, lying between Piru creek and the Sespe oil mining district. The latter was described in the eleventh Bulletin of the California State Mining Bureau. It is interesting to note how the probable dimensions and directions assigned to the Los Angeles and the Summerland oil fields in the bulletin referred to have been borne out by recent developments."

Illumination

NERNST'S ELECTRIC LAMP.*

BY JAMES SWINBURNE.

CONSIDERING the enormous importance of the incandescent lamp its improvement has received extraordinarily little attention. It limits us as regards pressure, it used to hamper us by its cost, it limits as as to variation of pressure, and it limits us very seriously by its inefficiency. Yet, in spite of these, the carbon incandescent lamp has made practically no advance in fifteen years. Of course mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but there has been no radical improvement. The jump to 200 volts from 100, or from 50 to 100, did not depend on any sort of radical improvement in the incandescent lamp; it was merely the result of detail improvements making it possible to produce long thin filaments. Other things being equal, it is easy to see that long thin filaments must be weaker. If the carbon has the same specific resistance the relation between pressure and length is $E=L^{\frac{3}{2}}$, and $E=D^{-\frac{3}{2}}$. If the filaments are flashed the proportions will be still more extreme. The question of high-pressure incandescent lamps is thus: How far can we make the filaments longer and thinner and flimsier without exasperating our consumers? Unfortunately the consumer is rapidly getting saddened as it is. The 100-volt 8 candle-power lamp does not please him much, and the 200-volt 8 candle-power lamp has in no way delighted him; if the lamp is made with two 100-volt filaments in series it combines the disadvantages of both without the advantages of the smaller candle-power of either. But it adds some further disadvantages peculiar to the higher pressure which I have not so far touched upon—and that is, the higher the pressure the more troubles there are through the silent discharge, or whatever it is called. I need only refer to the well-known experiment in which third terminal is sealed into the lamp. A galvanometer then shows a current going across country inside the lamp. This is, no doubt, intimately connected with the life, or rather with the death of the lamp.

I have dealt with the question of high-pressure incandescent lamps at some length because the subject is really of vital importance, and is too much neglected. Our technical colleges, and our technical press, and our technical societies pay the greatest attention to questions of a per cent. or two in the efficiences of dynamos and transformers, and give a good deal of attention to engines and boilers. That is because there is plenty of room for calculations in connection with these subjects, but the incandescent lamp, which at present holds the whole career of the lighting industry in the little curl of flimsy red-hot carbon that can hardly support its own weight, receives no attention at all. How much does the average electrical engineer know about incandescent lamps? The only subject that is treated in the same way is the cable. About half the money in town lighting goes in the cable—a mere fraction in the dynamos and transformers themselves—so the average electrical engineer knows nothing about cables.

So far I have only discussed the incandescent lamp; the arc lamp has also to be considered. I will not say much about the arc lamp just now, but will add a little more when the Nernst lamp is compared with it. The ordinary arc is limited in pressure to about fifty volts, including the series resistances necessary for regulating. The enclosed arc is a new development, which is more satisfactory as regards pressure and as regards consumption of carbon.

The lamp I describe to-night is the invention of Prof. Walther Nernst of the University of Gottingen. Though he is a young man, Prof. Nernst's name is already known to all modern chemists as a leading authority and original thinker in the field of physical chemistry. It is unusual for a man who has climbed to the top of one tree to jump to the top of another.

Nernst's, like most great inventions, is exceedingly simple as soon as it is understood. The efficiency of an incandescent body, as far as radiation goes, depends on the temperature of the filaments. The most refractory materials so far used in lighting are zirconia, which has been used to replace lime in the limelight, and the oxides or so-called rare earths, in the Welsbach mantles. I am aware, of course, that many people suppose that the Welsbach mantle is not very hot, treating it as if it were at a temperature, for instance, below the melting point of platinum. The light emitted is supposed to be due to some special power of selective emission due to the the oxides employed. I have had a good deal to do with incandescent gas mantles, and I find no reason to suppose that there is any magic effect of this sort going on. The part of the flame where the mantles hang fuses platinum wire easily, and very few materials can stand the temperature without fusing or volatilizing. Lime and many other oxides volatilize slowly from the mantles. I do not mean that the mantles are above the boiling point of lime; I have some idea of its melting point, as I have made a few pounds of melted lime and ran it out on the floor to look at it. The Welsbach mantles, which are now chiefly thoria, are at a temperature near their softening point, and in the making are raised to a temperature at which they begin to soften.

Nernst takes highly refractory oxides as his material. It does not seem promising, because such oxides are notoriously good insulators. But such insulators are electrolytes when hot. Nernst, therefore, heats the rods to make them conduct, and then heats them electrically, preserving a temperature which is within the limits that the material can bear without softening. This means that he can take the most refractory bodies supplied

*Abstract of a paper read before the Society of Arts, London.

by the whole range of chemical research, and can heat them to a temperature short of their softening point, and can thus get an efficiency unknown to workers on the incandescent lamp. Such efficiency also means whiteness of light so long as the efficiency is not too high. Thus the crater of the arc, being at a temperature of boiling carbon, gives a light that is unpleasantly blue.

The material is worked up into little white rods. Each rod is mounted on two platinum wires, a little paste made of refractory oxides being applied to the joints. The little rod with its two wires is then mounted on a holder which fits ordinary electric light fittings. As the rods fall in resistance as the temperature increases, after the manner of electrolytes, an increase of current produces a decrease of resistance. This tends to give some instability in running in parallel on supply circuits. This instability is corrected, as in an arc lamp, which has analogous properties, due to a different cause, by a series resistance. The Nernst rod has therefore a resistance in series. This is made up of exceedingly fine wire, and for ordinary circuits amounts to ten or twelve per cent. of the whole resistance of the lamp. The consumption, including the resistance, is 1.5 watts per candle power for large lamps and 1.6 for small lights or low pressures. In small or low-pressure lamps the loss of heat at the ends is larger in proportion.

Such a lamp as I have described will not light up of itself, for the rod is an insulator when cold. The simplest way to start it is to warm it up with a match, or better, with a small spirit lamp. Such a lamp as this is not only very cheap as regards first cost but very economical in running. The life of rods, running at an efficiency of two-thirds of a candle per watt, including the resistance, is already more than 500 hours in good specimens. If the Nernst lamp advances as much in the first few years of its existence as the carbon lamp did between 1880 and 1882, it will soon be made so well that the rods last a lifetime. When the rod is worn out a new rod with its wire mounts is all that is replaced. The whole lamp is not thrown away at all. The method of lighting I have described, though it may be used in many cases, such as large public rooms, is really a savage mode of ignition, fit only for dealing with uncivilized commodities.

The small lamps and the lamps of medium size are in practice started by a heating resistance. This is arranged close to the rod and in shunt to it. As soon as the rod is hot enough to conduct, its current works a tiny cut-out in the resistance circuit. In large lamps the heating system is a little more elaborate, as the resistance arrangement is arranged as a sort of hood which covers the rod. As soon as the rod conducts, not only is the resistance circuit broken, but the electro-magnet lifts the little hood clean off the rod. In all these forms, the rod and its mounting are replaceable without interfering with the rest of the lamp.

We now have to consider the part that the Nernst lamp is probably going to play in the near future.

Compared with the small incandescent lamps, as you deal with a material of much higher specific resistance, it is easy to give both small lights aud high pressures. The question of lighting is exceedingly important, though it appears trifling at first sight. People are so accustomed to lamps being turned on from the door without any further trouble that they will generally object to have to light them with matches or spirit lamps, but there are many cases in which it will be quite satisfactory to have one lamp with an automatic lighter to show you the way into the room, the rest being lighted with matches or a spirit lamp as needed. There will be, however, a considerable opening for the cheap, small-power, high-efficiency lamp, and the disadvantage as to lighting is small in such cases as cafes, restaurants, churches, hotels, railway stations, and, in short, in most public rooms.

Coming now to the next size—that is to say, lamps of 20 candle-power to 200 candle-power, and even small lamps in which it is worth while to have automatic ignition—the first cost of such lamps will be higher than the first cost of incandescents, but as the rod itself has alone to be replaced, that is a matter of very slight importance. This size of Nernst lamp, has, further, every chance of completely ousting the carbon incandescent on the score of cheapness, as to renewals, higher efficiency, better colored light, and, perhaps, more especially, high pressures. Once the Nernst lamp becomes so general that systems of distribution are laid out to suit it, instead of to suit the carbon lamp, the carbon lamp is practically "out of the running." It must be remembered that the Nernst can compete with the carbon filament at any pressure that suits the filament, but the Nernst lamp can easily go right out of the depth of the filament and have the higher pressures to itself. It must be remembered that at present the cost of cables in a system of distribution is an exceedingly large item.

Turn now to the large lamps, they compete with the arc lamp in efficiency. Of course the efficiency of the arc lamp is not a definite quantity. The candle-power is generally determined by multiplying the current by two and adding zeros at discretion. All I can say is, that however many zeros the good nature of the maker may supply, a Nernst lamp taking the same power gives a better light. When carefully arranged on the photometer, the arc may be better in given directions, but a lot of light given in directions that you do not want is not the same as the same light distributed with a uniform spherical emission. The arc lamps shown here will give the audience a good idea of the relative values. The Nernst gives a pleasanter, and of course, a perfectly steady light. Coming to costs, the Nernst will be very much cheaper in first cost, but enormously cheaper in maintenance. It also goes quite away from the arc as to pressures. There is no trouble, for instance, in making large lamps to work in parallel at 500 volts and by using double rods at 1000 volts. This puts an entirely new development of electric lighting in the hands of the engineer.

There is one point I have said little about yet. The incandescent lamp which is still with us gives trouble not only because of the low pressure it needs, but also because it demands that the pressure shall be kept uniform. It seems quite possible that the Nernst lamp may be made to stand a much greater variation of pressure than the filament. If this proves true it means an enormous difference in the designing of distribution mains. I do not like to say much about this yet as the invention is too young and too little time has been available to make much certain progress in that direction. Results are promising but it is best not to be too sanguine.

It is difficult to discuss an invention like this without being carried away with enthusiasm. I feel, however, that I have but feebly shown forth the probable future of what seems to me the greatest invention in electric lighting that we have seen for many years. Still I am sure I have not been too sanguine.

Transmission

REGULATION BY LEADING AND LAGGING CURRENTS.

THE unusually elaborate application of the various principles of alternate current working as applied to the regulation of the voltage of the Mechanicville-Schenectady transmission, forms an interesting feature that was not incorporated in the description of that installation as given in THE JOURNAL OF ELECTRICITY for September. This plant, as will be remembered, delivers power in two divisions to the General Electric Company, one for the testing department and the other for the running of the various motors driving the machinery of the shops. The former is supplied by a motor-generator set, consisting of a synchronous alternating current motor wound for high tension supply, coupled to a 500-volt multipolar railway type generator. The speed of this unit is obviously dependent only upon and equal to the speed in alternations per minute of the generators at Mechanicville and the voltage of the direct current end is thus obviously not affected by any changes of the voltage of the power delivered by the transmission line. The shop motors, however, are supplied

through step-down stationary and rotary transformers, and as the voltage of the direct current end of this sort of a transforming system is dependent on the alternating current voltage delivered, special means are necessary for properly adjusting the latter to obtain proper pressure on the distribution lines. The means adopted in this case are the use of leading and lagging currents by which the ohmic line drop can be inductively diminished or increased—a means previously used, notably in the St. Anthony Falls line—combined with an ingenious modification of a plan claimed in a patent issued to E. W. Rice, Jr., December 14, 1897.*

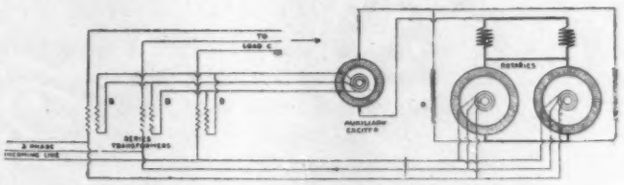
The system is practically compounded for constant potential at the direct current terminals of the rotaries, or it may be over-compounded at that point. The compounding is effected not internally in any machine, but strangely enough in the transmission line itself. The latter consists of three No. 000 wires all mounted on one cross arm, which gives double the self-induction between the two outside wires as between either of them and the wire in the middle, but this effect is neutralized by the transpositions of the lines, another purpose of which is the reduction of inductive disturbances in neighboring telephone circuits. The rotaries at the receiving end of the system are compound wound with quite a heavy series winding, the ampere turns of the two field windings being so proportioned that on no load the excitation of the shunt winding is sufficient to generate at synchronous speed a back electromotive force sufficient to choke back the impressed alternating current waves.

The result is that wattless currents lagging behind the impressed electromotive force enter the rotary armature and automatically increase the field excitation to a proper value. These lagging currents react upon the self-induction of the line, causing a drop considerably greater than that due to its resistance alone, and—the direct current voltage being practically proportional to the impressed alternating voltage at the rotary rings—the reduction of the latter by means of the increased line drop prevents too great a pressure being delivered from the direct current end on no load.

As the load rises, however, the action of the series fields of the rotaries begins to assert itself. As the direct current excitation of the fields increases the wattless currents in the armature necessary to maintain the field excitation fall off until at a point about three-quarter load the power factor of the incoming current approaches unity and the voltage drop on the line is equal only to the amperes multiplied by the line resistance. On further increasing the load the exciting action of the field windings of the rotaries becomes sufficient to generate a back electromotive force at synchronous speed greater than that delivered, and, as the rotaries cannot change their speed, but must remain in synchronism with the generators at the other end of the line, the alternating currents, so to speak, automatically cut down the field excitation by a flow of wattless currents leading to the impressed electromotive force. The action of this on the line inductance is the reverse of that of the lagging currents described above. In other words, the line drop is diminished and, in case the leading current and line inductance are of sufficient magnitude, the voltage-boosting effect in the line may even be greater than the ohmic or resistance drop, in which case the voltage at the receiving end is greater than that at the generating end. The direct current pressure being proportional to the alternating current pressure delivered, it is in turn compounded or even over-compounded if necessary. The direct current pressure delivered by the rotaries is thus increased just as though they were engine-driven generators, by the use of a compound winding, but the effect is not immediately due to action of an increased field flux on the armature conductors, but is due to a boosting or depressing action of the inductances of the transmission circuit on the alternating currents therein.

In the case of the Mechanicville-Schenectady system, there is, of course, in addition to the self-induction of the line, the self-induction of the rotaries and stationary transformers and the generator armatures, at least for the present. If at any later time other transmission lines are run from Mechanicville to other cities, it will become necessary to excite the generators for constant potential at the switchboard in order to prevent the various lines interfering with each other. In this case the self-induction of the generators cannot be depended upon, but at present the generator fields can be left at constant excitation and the voltage at Schenectady controlled entirely automatically by the compound fields of the rotaries, the self-induction of the generators materially aiding the inductive compounding.

This arrangement alone would be sufficient to obtain proper voltage regulation but for the interference of the load taken by the synchronous motors driving the generators of the testing department. Any increase of the load in this department increases the current in the line, consequently increases the ohmic or resistance drop without the proper compensating effect in the wattless currents taken by the rotary. Any variation also of the phase relations of the synchronous motor load will still further disturb the proper combination of the ohmic and inductive drop on the line, the sum of which two quantities should be, by the action of the rotaries described above, rendered a constant independent of the load. To make the rotaries take leading or lagging currents which shall balance out the disturbing effects of the synchronous machines the following system has been devised, this being, as



REGULATION BY LEADING AND LAGGING CURRENTS.

mentioned above, a modification of Mr. Rice's recent patent. The rotary shunt fields, as shown at *D D* in the accompanying diagrammatic illustration, are excited from a separate direct current 'bus bar which is fed with current from the main 'bus through an auxiliary exciter *A*. This auxiliary exciter serves to raise the voltage across the rotary fields, and is driven by an alternating current synchronous motor of the same number of poles, thus keeping its armature in step with the alternating system. It has no field exciting winding, but its armature is fitted with three collecting rings into which alternating current may be introduced from the secondaries of three small series transformers shown at *B*, the primaries of which are inserted in the lines feeding the synchronous motor *C*, and any other loads supplied over the same transmission line, with the exception of the rotaries. The armature of the auxiliary exciter is coupled to the synchronous motor at such an angle that the currents introduced from these series transformers, when the load passing through their primaries is of unity power factor, tend to set up a field of force in the magnetic circuit of the auxiliary exciter and build up a direct current voltage across the brushes thereof; thus the greater the load on the system *C*, the greater is the boosting action of the machine *A*, and the greater in consequence is the voltage across the field windings, *D*, of the rotaries. Further, if the load on the system, *C*, becomes lagging, tending thereby to still further increase the drop on the transmission line, the currents entering the armature of machine *A* lag also and excite to a correspondingly greater extent the field magnetic circuit of that machine, causing a greater current in the winding *D*, of the rotaries which, in turn, causes the armatures of the rotaries to take a leading current to cut down their excitation, this leading current balancing the lagging current of the load, *C*, and preventing any deleterious effect on the line drop. Vica versa, leading currents of the load, *C*, cut down the voltage across the shunt fields of the rotaries, *D*, causing lagging currents to enter the armatures thereof, which balance the leading currents and equalize their effect on the transmission system. In this way the load on the system, *C*, can vary in magnitude or phase relation by any amount within limits without affecting the voltage relation at the direct current terminals of the rotaries.

*See *The Electrical World*, February 12, 1898, page 219.

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EDITORIAL.

WE ARE BUT FINITE BEINGS.

The notorious inefficiencies of by far the greater varieties of illumination now in use, whether they be the open gas flame or the incandescent electric light, presages the time when science shall have rendered present methods obsolete. It is not supposable that steam engineering is to sit idly by and rest content with a condition of affairs which permits ninety per cent. of the energy of fuel to go up the stack, or that electrical engineering will forever continue on with the burlesque of running great so-called electric lighting stations ostensibly for the purpose of supplying light from the ubiquitous incandescent lamp, but in reality supplying some ninety odd per cent. of heat, and the balance, say six or eight per cent., in light. Lighting stations indeed; far better that they be called *heating* stations!

But what shall we say of the gas business, which is further along in years and ought to be the wiser? It submissively worships intermittent processes, which blow living volcanoes of flame heavenwards to warm the moon, and then enhances the monstrous loss by giving light from the open gas jet that is more inefficient as a source of illumination than even the incandescent electric lamp. There is some hope for the gas industry, however, as in truth there may be for the other banches of engineering science, for gas engineers have developed the highly efficient mantle which throws to the winds the paltry four or five per cent. in light efficiency of the gas jet in order to utilize to a far larger extent the ninety-five per cent. or so of heat which constitutes the energy of the open gas flame. This is eminently in the right direction, so far as the utilization of gas for purposes of illumination is concerned, and electric lighting industries have learned well the lesson that in the incandescent gas mantle is found a source of illumination which is neither to be ignored nor crowded out. And now a physicist, following the lead of the Welsbach success, has developed an incandescent electric lamp —the "Nernst" lamp—in which a rod of rare earths in the open air is rendered incandescent by electricity, with the result (so the inventor claims) that incandescent electric light is produced with one-third the consumption of energy required in the ordinary incandescent lamp.

Incandescent lamp development is working out its evolution slowly, very slowly, it seems. First came the ordinary incandescent electric lamp with its high resistance filament of carbon which reaches a high degree of brilliancy, and consequently a high efficiency as an illuminant, only when closely approaching the dangerous point of dissipation. Next came the incandescent gas mantle, which, like the incandescent electric lamp, derives its light-giving properties from heat. But the oxides of the rare earths used in the manufacture of incandescent gas mantles are superior to the carbon filaments of incandescent electric lamps in that the mantles are capable of being operated at higher temperatures, and consequently at higher incandescence, than the filament without vital risk of dissipation or serious danger to its life. In the Nernst lamp has been made a distinct advance over the carbon filament in that incandescent material is the superior to incandescent carbon, as commercially operated, as an illuminant—but the Nernst lamp has not yet passed beyond the laboratory stage.

Vauntful indeed are we of the electrical industry over the mighty achievements of our forces in their commercial conquests. But while we have cause to congratulate ourselves in some regards, should we not find time to pause and reflect that we are but groping darkly in the realms of science? That with all our boasted enlightenment we can not show that we are sufficiently masterful of the laws of science to enable us to turn to more useful account more than six or seven units of every one hundred that we make for purposes of incandescent electric illumination? That we are deplorably extravagant of nature's forces, and that it is only nature's immeasurable bounties and our own infinitesimal capacities that enable us to continue on in our narrow way of woeful waste? We are but finite beings! Our boasted conquests over science are but braggadocio, and so weak and paltry are our works that the generations of even the coming century will look back in wonderment at our ignorance.

POPULARIZING AUTOMOBILES IN EUROPE.

Mr. Jules Buse, an electrical engineer of Ghendt, Belgium, and who is well known in engineering circles throughout the continent, writes to Prof. Van der Naillen, of San Francisco, that notary Poelaert, of Brussels, has recently placed his official seal on the articles of incorporation of the "International Electrical Postal Society," which has been organized for the purpose of establishing along every public road, a series of electrical charging stations for the purpose of charging the storage batteries of automobiles traveling along these roads. The society was incorporated with a capital stock of eighteen million francs and its principal office is to be at Brussels.

The charging stations will be about ten miles apart and each will have the very best of accomodations not only for electrical automobiles, but also for bicycles and auto-

mobiles operated by petroleum. Each station will also contain, as an adjunct, a restaurant, medical service, a repair shop, a depot for petroleum and other necessary oils, and a complete assortment of duplicate parts of all machines. The first system to be established will cover all the first class highways of Belgium and France, and construction on the first line, which is to be commenced immediately, is to be along the government road from Brussels to Paris.

The execution of the program of the society seems to be destined to cause an unprecedented development in the newest line of electrical industry, namely, in the building of automobiles, and the American companies that have been organized to build will surely be among the first to receive benefits from the demand for automobiles that this praiseworthy project is bound to create throughout Europe.

Passing Comment

An Editorial Review of Current Events and Comtemporary Publications.

COST OF STEAM POWER.

A correspondent takes exception to the criticism which was made in the leading editorial in our January issue, as to the cost for fuel and labor for a 1200 horse-power steam plant, given by Prof. C. G. Baldwin as $113,000, and insists that this figure is not too low.

Assuming that a pound of oil will evaporate 12½ pounds of water, which is a thoroughly safe assumption, and that a horse-power may be obtained with a consumption of 20 pounds of steam per hour in the cylinders, it would require 40,820 barrels of oil to produce the 1200 horse-power for the year of 280 days, of 24 hours each. This oil at $1.50 per barrel would cost $61,230 and attendance in such a plant would figure about $8000, making a total of $69,230.

Taking the figures given by Dr. Chas. E. Emery in his paper read before the American Institute of Electrical Engineers on the cost of steam power, for a compound high speed condensing plant, the fuel bill would figure out $61,347, which checks very closely with the figures as based on evaporation and steam consumption.

We still feel that we are justified in saying that the labor and fuel cost of such a plant would be nearer $65,000 than $113,000.

MISTAKES WILL HAPPEN.

Our worthy contemporary, *The Mining and Scientific Press*, reprints verbatim the article on "Electricity in Mining," appearing originally in these columns in April last — which reproducting is eminently proper — but in doing so, it, through an evident oversight, attributes its authorship to *Electricity*, and not to THE JOURNAL OF ELECTRICITY, as should have been done.

By the way, the article referred to seems to have been favorably received by mining interests. It was also reprinted in the *Mining and Metallurgical Journal*, which gave it a radical endorsement in the statement that "miners interested in electrical power will find this article well worth preserving."

And now, as if to show how easily "mistakes will happen," apologies must be extended to the *Street Railway Journal*, for the inadvertance by which the abstract of the article by Dr. Louis Bell on "Rotary Converters in Railway Work," appearing on page 14 of the present volume of THE JOURNAL OF ELECTRICITY, was accredited to the *Street Railway Review*. This excellent article was reprinted from the former publication — not the *Review*.

PHASE INFLUENCES ON ROTARY CONVERTERS.

Steinmetz has contributed an article to *The Electrical World*, (Vol. XXXII, page 650), on "The Converter," which points out among many other valuable features, that the more phases there are to the alternating current supplied to a rotary converter, the less is the heating of its armature coils. It is shown from tables given that, assuming an internal energy loss of four per cent., and assuming unity as the power factor of the incoming current, a 100-kilowatt rotary must be limited, for the same copper heating, to a rating of 82 kilowatts, if used as a single-phase converter, but it may be run at 131 kilowatts with three-phase supply, at 161 kilowatts with four-phase supply (commonly known as two-phase), at 194 kilowatts with six-phase supply, and at 231 kilowatts with as many phases as there are commutator segments. These figures are, of course, based on the use of commutators properly proportioned for the increased load.

TWO ILLOGICAL CONDITIONS.

Advocates of municipal ownership, as well as those members of the electric lighting industry who decry the importance of the Welsbach mantle as a competitor of the electric light, will find little consolation from the experience of the corporation of Liverpool, England, which, it is reported, has found it more economical to light the streets of that city by means of Welsbach incandescent gas lamps than by electric light, despite the fact that the corporation operates an electric lighting plant for municipal purposes, while gas is furnished by a private company. Municipal ownership is as illogical as is antagonism between gas and electricity, and *vice versa*.

SAN FRANCISCO RANKS THIRD.

Messrs. Hale and Codman, have contributed to *The Electrical World* (Vol. XXXIII, page 19), some statistics they have gathered on the relation between the use of electricity and the population of the principal cities of the world, from which it appears that the central station capacity of San Francisco, when reduced to 16 candle-power lamp equivalents, is such that it has 598 lamps to each 1000 inhabitants. Rochester, N. Y., and Boston alone lead it, they having respectively 982 and 836 lamps per each 1000 in population. Should the capacity of isolated plants be added to that of the central stations, San Francisco drops to the fifth place, the figures then reading: Boston, 1232 lamps; Rochester, 1040 lamps; New York, 859 lamps; Chicago, 730 lamps, and San Francisco, 660 lamps per 1000 inhabitants.

Gas

ACETYLENE.*

BY PROF. VIVIAN B. LEWES, F. I. C., F. C. S.

III.

IN the generation of acetylene from calcic carbide and water all that has to be done is to bring these two compounds in contact, when they mutually react upon each other with the formation of lime and acetylene, while if there be sufficient water present the lime combines with it to form calcic hydrate.

I:

Water H_2O Lime

Calcic Carbide CaC_2 Acetylene

and II:

Lime	Water	Calcic Hydrate
CaO	H_2O	$Ca(HO)_2$

There are manifestly two methods by which the carbide and the water can be brought together, either by adding water to carbide or carbide to water, while a slight amount of novelty can be introduced by allowing the water to rise in contact with the carbide from below, *i. e.*, by bringing the water to the bottom of the carbide instead of to the top. In considering the various forms of acetylene generators it will be well to divide them in the first place into two classes: (1) The automatic, in which the storage capacity for acetylene is less than the total volume of gas the charge of carbide is capable of generating, and which depends upon some special arrangement for stopping the action of water on the carbide when the consumption ceases. (2) The non-automatic, with which there is a holder of sufficient size to contain the whole of the gas generated from the charge of carbide which is used.

GENERATORS.

Each of these classes may be subdivided under three heads:

(*a*). Those in which the water is, by various devices, allowed to drip or flow in a thin stream on to a mass of carbide, the evolution of the gas being regulated by the stopping of the feed water.

(*b*). Those in which water in volume is allowed to rise in contact with the carbide, the evolution of the gas being regulated by the water being driven back from the carbide, by the increase of pressure in the generating chamber, or by the rising bell of the gasholder drawing the carbide up out of the water.

(*c*). Those in which the carbide is dropped or plunged into an excess of water.

The points to be attained in a good generator are: 1. Low temperature of generation. 2. Complete decomposition of the carbide. 3. Maximum evolution of the gas. 4. Low pressure in every part of the apparatus. 5. Ease in charging and in removal of the residues. 6. Removal of all air from the apparatus before generation of the gas.

When carbide is acted upon by water considerable heat is evolved, the intensity of the temperature developed depending on the time needed to complete the action. The decomposition of the carbide by water is extremely rapid, and the degree of heat varies with every form of generator, so that while the water in one form may never reach the boiling point of water, the carbide in another may become red hot and give a temperature of over 800° C. When water drips upon carbide, as in generators of division *a*, the temperature rises rapidly until it reaches a maximum in about eighteen or twenty-five minutes, the actual heat developed depending upon the rate of flow of the water and the way in which it is distributed over the mass. But it is quite possible with generators of this class to reach from 400° C. to 700° C., and it is probable that in some parts of the mass the higher limit is nearly always attained.

Makers of automatic generators seem to think that all they have to do in order to stop the evolution of acetylene is to cut off the water supply, but instead of stopping then it continues to be evolved, although with increasing slowness for a considerable time. The results of experiments on this point show clearly that in any apparatus operating on this principle the cut-off should be arranged so that at least one-fourth of the total holder capacity is still available to store the slowly generated gas.

According to theory, 64 parts by weight of carbide require only 36 parts by weight of water to completely decompose them and convert the lime into calcic hydrate. This means that each pound of carbide requires a little under half a pint of water to complete the action, but in practice, owing to the evaporation due to the heat of the action, half the added water is driven off as steam with the acetylene or left mechanically adhering to the lime, and the smallest quantity likely to complete the action would be a pint to a pound of carbide, while in reality the only safe way is to add enough water to drown the residue.

The second subdivision of generators (*b*) in which water rises to the carbide, is very popular, and overheating can be avoided in these provided they are so arranged that the water is driven back from the carbide and that the charge of carbide used is not too great. Under these conditions, the slowly rising water is always in excess at the point where it decomposes the carbide, so that the evaporation by rendering heat latent, keeps down the temperature, and although the steam so formed partly decomposes the carbide, in the upper portion of the charge, the action is never sufficiently rapid to give any very great rise in temperature. In the best generators of this class it is unusual to find that the melting point of tin, 228° C., has been reached in the carbide during decomposition. Where apparatus of this class are automatic and have no rising holder to take care of the gas, they work satisfactorily when supplying the number of lights for which they were designed; but if they are over-driven and the action becomes too violent, excessive heating takes place, while the turning off of the gas and consequent driving back of the water from the carbide also has a tendency to it. If, however, the water has risen sufficiently slow, the carbide below the surface has been practically all decomposed, so that the heating only takes place over a limited zone.

The generators of subdivision *c* are the worst offenders as regards excessive heating, the charge of carbide in some of them frequently becoming red hot, while the lime taken from them is highly colored, and often black, from the formation of tar and carbon.

The moment acetylene is subjected to the action of high temperatures, changes of great complexity begin. These are at first purely synthetical. At temperatures which are comparatively low, the acetylene begins to condense to benzine. As the temperature rises, the condensation of four molecules of acetylene yields styrolene. A further increase in the temperature may cause the benzine and styrolene to interact, yielding anthracine and hydrogen; and it is probably at this point that the brown tar vapors appear, while napthalene is also formed. At this temperature, moreover, a fresh set of interactions start. The nascent hydrogen combines with acetylene to form ethylene, and this body, under the action of heat, breaks down into methane and acetylene once more. In generators in which excessive heating takes place, the tar is very likely to cause considerable trouble, but a still more important evil is to be found in the alteration which takes place in the composition of the gas, and which reduces its illuminating power to a considerable extent. A sample of gas taken while the charge in one of these generators was over-heating, gave the following result on analysis: Acetylene, 70.0 per cent.; saturated hydrocarbons, 11.3 per cent.; hydrogen, 18.7 per cent. Such a mixture has only about one-half the illuminating value of pure acetylene.

At first sight these results seem an absolute condemnation of the second subdivision of apparatus; and the rising bell which draws a mass of wet carbide above the surface of the water should be at once discarded, as it is bad from every point of view. But generators in which water rises from below and so attracts the

*Abstract of a series of four Cantor lectures delivered to the Society of Arts, London.

carbide, can be made safe if the arrangements are such that the water can never be driven back from the carbide, and the bulk of the carbide is sufficiently subdivided.

The generators of the third class, although exhibiting great advantages in that their form renders it impossible to get above a temperature of 100° C., so long as there is water present, has the drawback of being the least economical in the output of acetylene per pound of carbide used, as the gas, having to bubble through the water, is rapidly dissolved by it, while in an apparatus in which only the surface of the water touches the gas, the amount dissolved is small, The result of this is that with generators of this class the generation rarely exceeds 4.2 cubic feet of acetylene per pound of carbide, instead of over 5 cubic feet per pound.

In generators of the first subdivision there may be a small quantity of the carbide left undecomposed, if water enough to flood the residuum be not admitted, while in non-automatic generators of the second subdivision this is practically impossible. In generators of the third subdivision, in which carbide drops into a large excess of water, is found the worst offender in this respect, for, if the generator has been in action for some time, a thick sludge of lime collects at the bottom of the generator, into which the carbide sinks, and a large lump of carbide will often bake for itself so tough a layer of oil and lime that it resists the action of the water, and is found unacted upon when the generator is cleaned out. The usual explanation given by the generator maker is that it is crust present in the "bad carbide." In a good generator the maximum yield of gas should be evolved from the carbide, but it is a fact that if you take a number of different machines and supply them all with exactly the same carbide, no two will give the same yield of gas, the best generators giving volumes approximating 5 cubic feet per pound of carbide, while the worst will give barely 4 cubic feet, a result; as usual, placed at the door of the carbide.

The causes which tend to diminish the volume of acetylene given off are:

1. Undue pressure in the generator.
2. The acetylene after generation having to pass through water.
3. Undue heating, causing polymerisation.

The first, which is very noticeable, is due to the increased volume of gas dissolved by water under pressure. Although 10 volumes of water at atmospheric pressure only dissolve 11 volumes of acetylene, at two atmospheres pressure it dissolves double the quantity. When acetylene is generated above the surface of water, but little dissolves at once, the top layer of water rapidly becoming saturated; but when the gas has to bubble up through a mass of water, as in generators of the third class, a heavy loss from solution takes place. The pressure in all parts of a generator should be as nearly equal and as low as possible, and this is best obtained by working freely into a gas holder of sufficient size. I think it is a mistake to allow more than 20 inches as the limit of permissible pressure in generators.

One pound of pure calcic carbide yields 1.15 pounds of slacked lime, and experiments made show that one pound of carbide will yield eight pints of lime sludge, which can be got rid of by a sludge cock at the bottom of the apparatus.

As to explosiveness, working with 90 litres of the various mixtures of acetylene and air in an explosion cylinder, and measuring the pressures by means of a manometer and indicator, the results given in the following table were obtained, the first column giving the percentage of acetylene in the mixture with air, and the second giving the pressure of the exploding mixture in atmospheres.

ACETYLENE.	PRESSURE.
2.5 per cent.	0.5 atmospheres
3.7 "	3.7 "
4.7 "	4.9 "
5.5 "	5.2 "
6.6 "	6.8 "
7.7 "	8.2 "
8.3 "	8.6 "
9.1 "	9.7 "
10.0 per cent.	11.1 atmospheres
11.1 "	11.1 "
12.5 "	10.6 "
16.6 "	7.2 "
20.0 "	16.0 "
25.0 "	16.9 "
33.0 "	18.4 "
50.0 "	20.3 "
66.0 "	10.0 "
80.0 "	6.3 "

If a mixture of equal volumes of acetylene and air be ignited in an open cylinder 18 inches high, a lurid disc of flame runs down the cylinder, and a vast cloud of carbon is given off, but no sign of explosion occurs. If, however, this is done in a closed vessel, the very slowness of the combustion brings about the explosion, as the combustion of the portion of the mixture first ignited creates a pressure under which the remainder detonates at the temperature of combustion, and given the high pressure noted. I have found it extremely difficult to ignite such a mixture by means of an electric spark, but if a flask is employed to that there is a considerable volume of the mixture present, the spark at once causes a violent explosion.

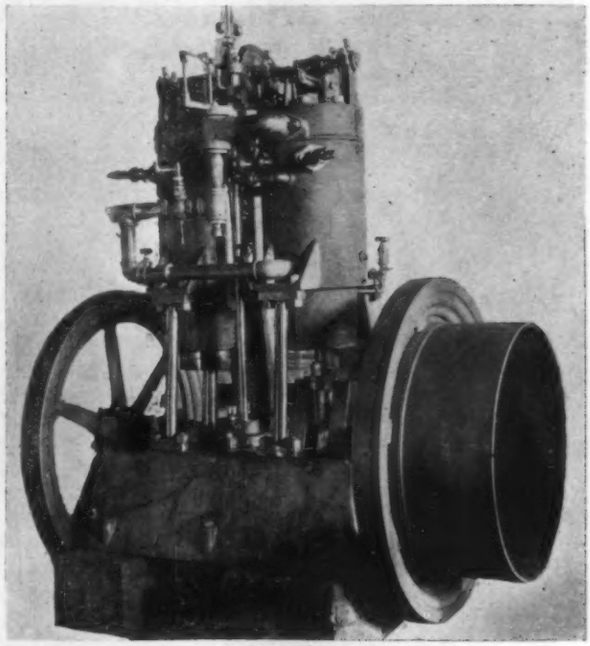
An analysis by Dr. Wolff of acetylene generated from American carbide as at present made, gave the following: Phosphoretted hydrogen, 0.05 per cent.; sulphuretted hydrogen, 0.08 per cent.; ammonia, 0.08 per cent.; hydrogen, 0.09 per cent.; nitrogen, 0.42 per cent.; oxygen, 0.87 per cent.; acetylene, 98.41 per cent.

(To be concluded in March number.)

RECENT USES OF THE GAS ENGINE.

BY CHAS. H. F. LÜBCKE.

IT may be of interest to quote a few instances where the gas engine has effectually taken the place of steam power. Recent developments carry the conviction that the gas engine is advancing and gaining valuable ground in the manufacturing industries as a prime mover, and that it may oust its rival, the steam

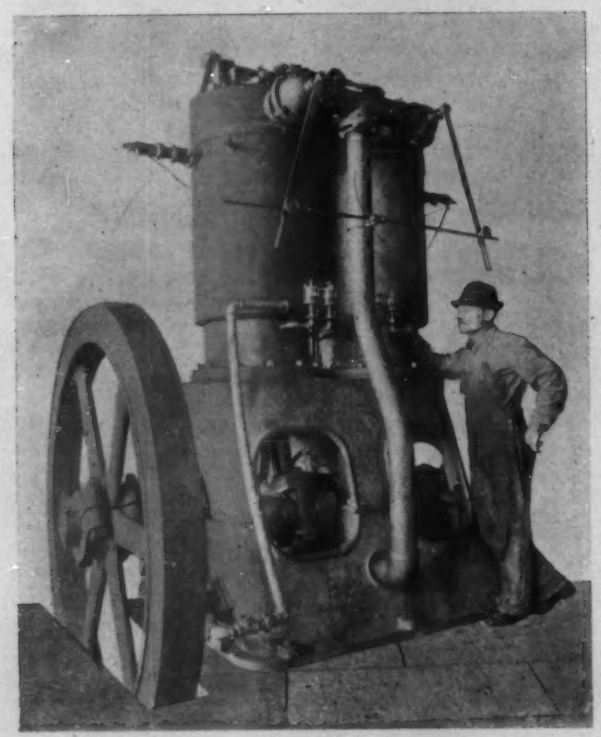


A CALIFORNIA-BUILT "MARINE TYPE" GAS ENGINE FOR DYNAMO DRIVING.

engine; for, is there not found in the gas engine a solution for the problem of obtaining power from heat in the simplest way? That this is true is proved by the increased economy realized in using the gas engine.

About a year ago it was found necessary to install an electric light plant at the Ingleside racetrack, San Francisco. After due consideration the gas engine was adopted as the motive power. The engine was built by the California Gas Engine Company, of San Francisco, and the dynamo was of a familiar multipolar type. The engine has four cylinders, and as it is constructed on the Otto four-cycle type, it receives one impulse every stroke. The engine when running normally develops fifty horse-power. The dynamo is driven by a belt, from a pulley located on the center of the engine shaft, two cylinders being on each side of it. The strain of the shaft is, therefore, very evenly balanced.

It may be easily shown that this engine has advantages over the single cylinder fifty horse-power gas engine. The equivalent



A CALIFORNIA-BUILT GAS ENGINE FOR MARINE USE.

of fifty horse-power in heat is distributed to four cylinders, therefore each cylinder will be much easier to keep cool, the strain on the metal will be less, and the initial pressure will be expanded down further than is the case with the single cylinder engine. Furthermore, the strain on the crank shaft is more even, a very decided advantage in gas engines. Also the weight of the fly-wheels may be made considerably less. The engine is supplied with a throttling governor, which regulates the speed at 2¾ per cent.

The ignition of the gases is accomplished by the electric spark, now most commonly used in America. The electric spark is introduced into the cylinder by the Woltenbaugh patent igniter. This igniter has the advantage over the common spring igniter in that a solid musket steel point produces the spark. This steel point connects by a rod to a spiral steel spring outside the cylinder. The spring being outside, it is not affected by the heat in the cylinder; furthermore it is always in plain sight, and the tension of it may be adjusted by hand while the engine is running.

The output of this plant is 300 sixteen-candle-power incandescent lights and 20 arc lights, the dynamo furnishing current at 110 volts. It may be stated here that the variation in the current does not exceed three volts. One attendant operates engine, dynamo, and switchboard, as the engine requires no more attention than filling the oil cups. This plant is in successful operation, and furnishes light at one-eighth gallon of gasoline per horse-power per hour. This fact may well be noticed and be compared with the amount of fuel burned under the boiler of a modern steam engine. There are many other cases where the gas engine has superceded the steam engine, principally where small power is required.

During the summer the same company supplied Mr. George Oulton, of Twitchel Island (Sacramento river), with a fifty horse-power, vertical, double cylinder, marine type engine for reclamation purposes. The gas engine operates by belt a fifteen-inch centrifugal pump, throwing 10,000 gallons per minute. The elevation is fifteen feet. This engine, as indicated by the name "marine type," is an ideal marine or boat engine. It is not closed in like most vertical gas engines, but has cast iron columns at the back and polished steel columns in front, supporting the cylinders. All working parts, that is, connecting rod, and crank pin brasses are in plain sight, well adapted, and provisioned effectively with lubrication. This engine is furnished also with a throttling governor, Woltenbaugh igniter and sparking dynamo.

The best gas engines are now furnished with an adjustment for timing ignition while the engine is in motion. It is of vital importance that the gases in the cylinder should be ignited at the proper time to insure complete combustion, thus giving the utmost economy in the operation of gas engines. As found by extensive trials, the instant of ignition, to insure the best results, occurs just before the crank arrives at the upper dead center. Now any engine supplied with the ordinary fixed sparking arrangement, will not start if the spark is set ahead of the center; it will simply kick back and try to run the wrong way. It was therefore found necessary that a means should be provided by which the engine will start with the spark set at, or a little after, the center; but when the engine is running the igniter may be manipulated so as to set the spark earlier, to any point desired, in relation to the crank.

There has been, and there still is, a great prejudice among the public that the gas engine is unreliable and very easy to get out of order. Let me say to those who still entertain the prejudice, that if one half as much care was exercised in handling the gas engine as is now done with boilers and steam engines, all the unreliability of the gas engine would vanish, and it would occupy today the front rank of all motive powers. Manufacturers of gas engines, both in this country and in Europe, are improving their engines steadily, and they are very often greeted by success. With all respect for the steam engine, the gas engine has come to stay, and why? Because it delivers the horse-power per hour cheaper than is done by the most modern steam engines of today.

DIESEL MOTORS AND OTTO GAS ENGINES.

IF we are to judge by remarks recently heard in a conversation on internal combustion engines, the difference between the operation of the Diesel motor and the Otto gas engine does not appear to be generally understood. The first stroke of the Otto gas engine draws a mixture of air and gas into the cylinder, the second stroke compresses it, at the beginning of the third stroke it is exploded, and during the third stroke the piston is driven forward as the result of the explosion, while the fourth stroke expels the burned gases from the cylinder. The operation of the Diesel motor is entirely different. The first stroke draws air into the cylinder, the second compresses it to 600 pounds per square inch, at the commencement of the third stroke oil is forced into the cylinder against the high pressure by means of a small auxiliary pump driven by the engine and is immediately exploded by the heat generated by the compression, the piston is driven through the third stroke by the force caused by the burning oil, and the product of combustion is expelled during the fourth stroke. The air compressed by the pump referred to is also used in starting the engine, and this gives the Diesel motor an advantage over others by being always ready to start. The consumption of petroleum, according to Prof. Scroter in a paper read before the Institution of Civil Engineers, (England) last year, is 0.524 pound per brake horse-power, and 0.396 pound per indicated horse-power hour.—*American Engineer and Railroad Journal.*

Personal

MR. A. J. COFFEE has been appointed Pacific Coast agent of the Gamewell Fire Alarm Telegraph Company, vice Mr. R. A. Rose, resigned.

MR. SIDNEY SPROUT has been appointed superintendent of the famous Rawhide mine, the duties of which position will consume his entire time, and necessitates his removal to Sonora, Tuolumne county, Cal.

MR. WALLACE W. BRIGGS has resigned the electrical engineership of the San Francisco office of the Fort Wayne Electric Company to accept a position as salesman with the Westinghouse Electric and Manufacturing Company at San Francisco.

MR. JOHN W. BROOKS, founder of the Brooks-Follis Electric Corporation, and now western sales manager for the Fostoria Incandescent Lamp Company, was married to Miss Winifred Cole, the charming and accomplished daughter of Mr. and Mrs. N. P. Cole, of San Francisco, on January 10th. The happy couple left for Chicago immediately after the ceremony, and the congratulations of hosts of well-wishers, including THE JOURNAL OF ELECTRICITY, have accompanied them to their new home.

MESSRS. EDWARD H. BENJAMIN, mining engineer, A. M. HUNT, mechanical and hydraulic engineer, and WYNN MEREDITH, electrical engineer, have become associated for the purposes of general consulting, constructing, and supervising engineering, with offices at 331 Pine street, San Francisco. Mr. Hunt, of the late firm of Hasson & Hunt, and more recently chief engineer of the department of navigation of the Alaska Commercial Company, is by far too well and favorably known throughout California to require further introduction, while Mr. Benjamin, who is secretary of the California State Miners' Association, is one of the most able mining engineers in the west. Mr. Meredith, who has won for himself a high standing in the electrical and transmission field, was associated with Mr. Sidney Sprout as assistant to the chief of the operating department of the World's Columbian Exposition, at the termination of which they came to San Francisco, serving as assistant electrical engineers of the Midwinter Fair. Mr. Meredith then became electrical engineer for the late firm of Hasson & Hunt, where he remained until its dissolution some months since. The new engineering association is the strongest that has yet been formed, and its personnel presages the opinion that it will become a potent factor in western engineering developments of the near future.

Literature.

"Commercial Cuba; a Book for Business Men," by William J. Clark, with an introduction by E. Sherman Gould, Mem. Am. Soc. C. E.; 514 pages, 6¼x9½, octavo, cloth, with eight maps, plans, and 40 full page illustrations and a commercial directory appended. Published by Charles Scribner's Sons, New York, 1898. Price, $4.00.

This timely work is read with the same interest with which one listens to after-dinner tales of adventure from the lips of some traveler of renown. It reads like a book that was "talked-off," not written, and in consequence, much of a statistical or encyclopedic nature is interwoven with descriptive matter in a style that both interests and instructs. However desirous the reader may be in learning of the social customs and civilization of our Cuban proteges, he cannot do otherwise than become impressed with the commercial possibilities of the new Cuba, for the author has packed the book with facts gathered from personal observation and official reports, that give exhaustive information concerning the condition and possibilities of every industry on the island, each town and district being critically examined with a view of presenting authentatively the outlook for American capital, backed by American energy. The chapters deal with social and hygienic questions, legal procedure, political matters, public improvements, railways, both steam and electric, turnpikes and roads, harbor and dock facilities, telegraph, cable and telephone lines, contract labor, agriculture, mining and manufacturing in all of its branches, and a multitude of other subjects of interest to business men who are looking to Cuba as a field for investment or as a market for goods.

One cannot but be struck with the enormous energy and unbounded resources displayed by the man who, in the brief time that has been at his command since a commercial interest in Cuban affairs has been awakened in the United States, has written and compiled the exhaustive work now in hand, and has done it with a painstaking thoroughness that ordinarily would have consumed years of travel, writing and compilation. Mr. Clark's wide experience in foreign commercial affairs, however, peculiarly fits him for the position he occupies, namely, that of general manager of the Foreign Department of the General Electric Company, with headquarters in New York City, which fact renders the book of the greater interest and value to electrical readers.

Hydraulics

ELECTRIC UTILIZATION OF WATER FALLS.

THE first item of expense in electrically utilizing a water power is the amount required for water privileges. In some cases this is rather an unimportant consideration, while in others it is the chief expenditure, for it may involve the buying of thousands of acres of land surrounding the stream, because the necessary dams may cause to be submerged a great deal of valuable land, or large tracts have to bought for building storage reservoirs, or the right of way for pipe lines, etc., have to be secured. When land is cheap these considerations are often not objectionable, but where good farming land, or land valuable for other reasons, has to be thrown to waste, the question may be a very perplexing one.

The cost of the dam, power house, and hydraulic machinery is, as a rule, dependent almost entirely on the characteristics of the stream that is being utilized. Entering into the question is the amount of water in the stream, both under normal as well as abnormal conditions at various seasons of the year; also the head or fall, and whether it is dependent on natural conditions or requires the building of large dams. Generally speaking, other things remaining equal, generating plants, comprising the power house, hydraulic and electric machinery, as a whole cost less as the head increases, until certain limits have been reached. When the head is low, ranging from four to ten feet, it requires a comparatively large wheel for a relatively small amount of power, and then only slow speeds can be attained. When large units are desirable, a number of such wheels must be coupled together in order to get the required power. The speed required can be raised or lowered to a certain extent, depending on the size of the wheel. If higher speeds at low heads be desired for large units, many wheels must be operated together, requiring not only a great deal of room, and consequently a larger power house, but considerable line shafting, gears, couplings, etc., which not only increase the initial cost, but increase the cost of operation and maintenance of the plant, as well as introduce another source of inefficiency. With higher heads a larger amount of power can be obtained from fewer and smaller wheels, with higher speeds, and, therefore, cheaper generating apparatus.

The cost of generating apparatus for a given capacity, other things remaining equal, is almost directly proportional to the speed at which it runs, and for this reason it is always desirable to refrain from too low speeds wherever possible.—D. W. MAGIE, in *Cassier's Magazine*.

TO DRILL HOLES IN GLASS.

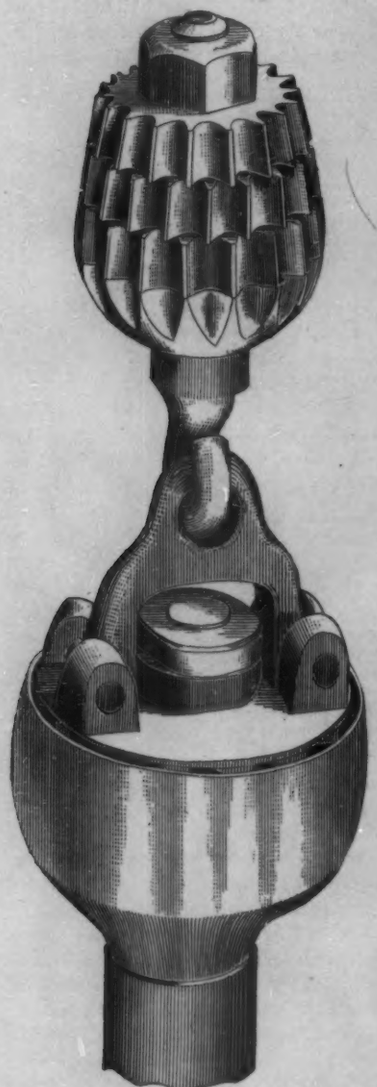
Holes can be easily drilled in glass with an ordinary drill, if the spot is moistened with a few drops of a mixture composed of 25 parts of oxalic acid in 12 parts of turpentine. Keep tightly corked.

Industrial

In Responding to Advertisements in this Publication, please mention "The Journal of Electricity."

A REMARKABLY EFFICIENT TUBE CLEANER.

EVER since the introduction of water tube boilers they have steadily grown in favor among steam users, but like all other good things, they have their weak points. Their main drawback is the immense amount of time and labor required to keep them clean. The scale will form and burn on to the inside of the tubes, and it is almost impossible to thoroughly remove this scale by any of the crude appliances, such as the different kinds of hand scrapers.



THE "GO-DEVIL" TUBE CLEANER.

The invention of the rotary tube cleaner, driven by water power (the water serving a double purpose of driving the motor and washing out the scale, loosened by the cutters) was expected to be a long step in the right direction, and the immense amount of time and labor required for cleaning water tube boilers was supposed to thus become greatly reduced and the work simplified. However, the first of the cleaners was a crude affair. It required a large amount of water to run the motor, and produced very little power, with a very small cutting or scraping effect. Several improvements were made on this kind of machine, and other machines were invented, all combining the same rotary principle, but none of them have proved efficient. Some lacked power, and all were complicated affairs that wore out too quickly. Some of them were only suitable for straight tubes and even then could not do the work if the scale was hard and thick. All of these imperfections became apparent and were commented upon by engineers in general, which rather gave the rotary tube cleaner a set-back for a time.

The inventor of the "Go-Devil" Tube Cleaner has finally solved the problem of doing quick and efficient work. The "G.-D." tube cleaner is made of brass and steel, fitted with ball-bearings, and is very clearly set forth by the engraving. Four $\frac{1}{16}$-inch conduits supply all the water required to a disc motor, which is fitted with reaction buckets situated close to the edge of the outer circumference of the disk, thus giving the largest amount of power for the smallest amount of water. The speed of this wheel, when subjected to a water pressure of sixty pounds to the square inch, is from 2000 to 4000 turns a minute. The cutter head is made up of three disks of steel, with teeth milled in the edges and set staggering, and when assembled form a sort of pear shaped cutter head of considerable weight.

The operation of this device is somewhat peculiar, in that there are two distinct motions imparted to the pear shaped head or cutter, which can only be described as follows:

First: There is a spinning motion due to the water motor.

Second: A gyrating, roweling, spiraling motion, due to the contact of the teeth in the cutter head on the tubes, and also to the fact that the pear shaped head is smaller than the inside diameter of the tube.

The direction of this gyrating, roweling, spiraling motion is opposite to the spinning motion mentioned, and it has a pounding, beating, and smashing effect, large pieces or flakes of scale being dislodged by its action, the force of which can be regulated by the water supply. It is due to this combination of motions and the weight of the cutter that the "G.-D." tube cleaner shows its wonderful efficiency, speed and thoroughness of work.

One of the most valuable features of the "G.-D." tube cleaner is the ease with which it cleans off scale from the outside of fire tubes in a tubular boiler. To perform this seeemingly impossible work, it is only necessary to change the cutter head, putting on a special cast iron head, hexagonal in shape, which, when entered into the tube and rotated at a high speed, beats and hammers the inside of the tubes, thus cracking off and removing the scale which has formed on the outside of the tube. This should be done when the boilers are opened for cleaning, as the scale is then dry and cracks off easier, the motor being operated by either steam or water, which gives an opportunity for removing the scale, which is thrown down on the boiler sheet; or it can be done while the boiler is under steam, in which case steam is used as the motive power for the driver. For cleaning out the soot and carbon scale in fire tubes, a wire brush is substituted and the motor driven by steam, thus taking out every particle of soot in the tube and leaving it as clean as when new.

It is believed that the "G.-D." tube cleaner will recommend itself to steam users, and a trial of this certainly meritorious device is solicited by the Pacific Coast Machinery Company, Pacific Coast and Hawaiian agents, 12 Fremont street, San Francisco.

TABLE OF CONTENTS.

Illustrated articles are designated by an asterisk (*); Editorials by a dagger (†); Passing Comment by a double dagger (‡), and Industrial by a section mark (§).

Gas

Acetylene—III, by Prof. Vivian B. Lewes, F. I. C., F. C. S. 32
Diesel Motors and Otto Gas Engines 34
*Recent Uses of the Gas Engine, by Chas. H. F. Lubcke 33

Historical

The Heretofore Unpublished Facts of the Pomona Case, by C. G. Baldwin 23

Hydraulics

Electric Utilization of Water Falls 35

Illumination

Nernst's Electric Lamp, by James Swinburne 27
‡San Francisco Ranks Third 31
‡Two Illogical Conditions 31
†We Are But Finite Beings 30

Literature 35

Miscellany

‡Mistakes Will Happen 31

Personal 35

Steam

§A Remarkably Efficient Water Tube Cleaner 36
A Test of California Fuel Oil, by A. W. Hunt, M. E. 24
‡Cost of Steam Power 31
Development of California Oils 25
Fuel Oils of California, by Geo. H. Larkin 24

Transmission

‡Phase Influences on Rotary Converters 31
*Regulation by Leading and Lagging Currents 28
*Three-Phase Transformer Manipulation, by A. J. Bowie, Jr. 21

Transportation

†Popularizing Automobiles in Europe 30